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Reshaping Great Lakes Pine Forests: Adapting to Drought and Climate Change

Change in the North Woods

The red pine forests of the western Great Lakes region aren't what they used to be.

For a century, scientists and foresters have viewed these forests as structurally simple, single-cohort stands of red pine (*pinus resinosa*) originating after stand-replacement fires. Forest managers emulated this perceived model in their management and have long grown even-aged red pine plantations.

But after a century of this approach, along with fire suppression and a changing climate, these forests are showing signs of stress. The climate is warming, and forests are suffering from more frequent short-term droughts, potentially endangering the livelihoods of local communities dependent on a robust forest products industry, as well as local cultural values and many regional wildlife and plant species that depend on healthy, resilient forests.

The Cutfoot Experimental Forest has been the site of climate change research by the Northern Research Station and its partners. Photo by Eli Sagor, Univeristy of Minnesota, used with permission.

KEY MANAGEMENT CONSIDERATIONS

- For decades, scientists and land managers in the Great Lakes region have considered red pine forests to be high-density, even-aged, and mostly single-species forests, whereas research shows these forests were more species-rich and structurally complex, often including a mix of up to 12 tree species with complex age classes.
- Examination of past research and old growth areas has found that red pine forests in the Great Lakes, historically characterized by frequent fires, were less dense and more diverse than they are today.
- Species and age diversity, along with lower forest density and larger canopy openings, have been shown to benefit the resilience of these forests to drought and other stressors related to climate change.
- This resilience can be achieved through emulating historical disturbance patterns, such as with recurring prescribed fire or the use of silvicultural techniques. Variable retention harvesting, as described here, combined with site preparation, can return structural complexity to stands that are currently ill-equipped for projected environmental conditions.

This is the reason for Brian Palik's research in the Cutfoot Experimental Forest in north-central Minnesota. A Northern Research Station forest ecologist based out of Grand Rapids MN, Palik's two areas of specialty come together in Great Lakes forests: silviculture based on natural models and adapting forests to an uncertain climate future. These themes are the basis for Palik's recently published book, "Ecological Silviculture: Foundations and Applications."

Iconic Red Pine Forests

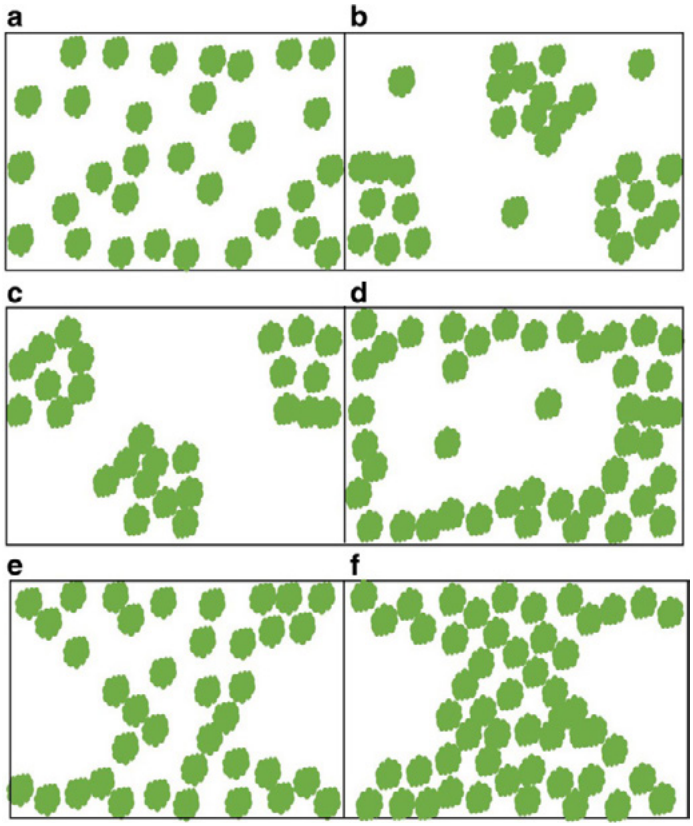
According to Palik, "The North Woods of the Great Lakes region are defined by these iconic red pine forests. For decades, scientists and managers have looked at these forests as places where nearly all the trees were red pines, and most of the trees in a given area were the same age because of stand-replacing fires."

However, a closer look at old-growth areas and historical evidence suggests a different story. "We're finding that in some places, the forests looked pretty different a century or more ago," Palik says, adding, "There was more species diversity, for one thing, because most fires didn't completely replace the stands. There was also lower density prior to when the forests were managed for timber."

Applying the Research

Palik says that this research is important because even-aged, single-species stands can be more vulnerable to environmental stressors. "The projections are for increased frequency and severity of drought in this part of the country," he says, adding, "Certain species are more adaptable to future conditions, and we need to get them back in the mix. Species such as northern red oak and white pine—species more associated with southern climates—are doing really well in the North Woods. But red pine, paper birch, and white spruce are not projected to do as well."

As the climate changes, forest conditions in Chippewa National Forest and across northern Minnesota are starting to resemble those of southern Minnesota. Photo from USDA Forest Service, Chippewa National Forest.



Conceptual representation of various types of variable retention harvesting in red pine ecosystems. Retention may be implemented as dispersed trees (a) or aggregated with or without some dispersed trees in the harvested matrix (b, c). Alternatively, retention may be implemented as large gap (patch) openings with a few retained trees in the opening (d) or as smaller patch openings with or without thinning of the forest between the openings (e, f).
Source: Palik and Anthony 2019.

Working with a partnership called Adaptive Silviculture for Climate Change (ASCC), Palik and partners, including the Northern Institute of Applied Climate Science (NIACS) and several universities, are monitoring tree growth, health, and survival in red pine forests of the North Woods. Through this research, they have come to realize that restoring certain characteristics from 100 years ago may be the key to long-term survival of these stands.

The scientists have developed a silvicultural model for red pine forests that emulates the natural cycles of disturbance. One management approach called variable retention harvesting (VRH) may hold promise. This approach, which has been implemented in other forests characterized by severe, infrequent disturbance regimes, is described in a 2019 journal article that Palik co-wrote entitled "Variable Retention Harvesting in Great Lakes

Mixed-pine Forests: Emulating a Natural Model in Managed Ecosystems." According to the article, VRH application in a red pine ecosystem should reflect the often severe but partial canopy removal from natural disturbance that favors the retention of larger-diameter trees, a variety of tree species, and large openings surrounded by a less disturbed matrix.

"With VRH," Palik says, "you manage a forest in a way that keeps it structurally complex in terms of age, species mix, and other factors. A key aspect to this kind of management is that when trees are thinned or harvested, you leave behind some of the structure of the previous stand, making sure to allow a healthy species mix with trees that we know do better during periods of drought." Combining VRH with other silvicultural treatments, such as prescribed fire or mechanical site preparation, can help enable establishment of a range of tree species.

Palik and others have concluded that only by having a deeper understanding of natural disturbance and structural outcomes can silvicultural approaches be designed that better emulate the natural model. And only by emulating a natural model—adapted for anticipated climate change—can many forests across the Great Lakes region be made more adaptable for the use and enjoyment of future generations.

Project Lead

Brian Palik is a forest ecologist at the Northern Research Station in Grand Rapids, Minnesota. Additional information on Brian and his research can be found at www.nrs.fs.fed.us/people/Palik.

The Cutfoot Experimental Forest has been the site of climate change research by the Northern Research Station and its partners with the Adaptive Silviculture for Climate Change project. Pictured from left to right are Dr. Chris Swanston, NIACS Director and NRS scientist; Palik; and Dr. Linda Nagel, Colorado State University, ASCC Network lead. Photo by Maria Janowiak, USDA Forest Service.

FURTHER READING

Bottero, Alessandra; D'Amato, Anthony W.; Palik, Brian J.; Bradford, John B.; Fraver, Shawn; Battaglia, Mike A.; Asherin, Lance A. 2017. Density-dependent vulnerability of forest ecosystems to drought. Journal of Applied Ecology. 54(6): 1605–1614. https://doi.org/10.1111/1365-2664.12847.

Palik, Brian J.; D'Amato, Anthony W. 2019. Variable retention harvesting in Great Lakes mixed-pine forests: emulating a natural model in managed ecosystems. Ecological Processes. 8(1): art. 16. 15 p. https://doi.org/10.1186/s13717-019-0171-y.

Palik, Brian J.; D'Amato, Anthony W.; Franklin, Jerry F.; Johnson, K. Norman. 2020. Ecological silviculture: foundations and applications. Long Grove, IL: Waveland Press, Inc. 343 p.

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